

**Compliance and Implementation  
Monitoring of Forestry  
Best Management Practices  
For Harvesting in South Carolina  
2007-2008**



**Compliance and  
Implementation Monitoring  
of  
Forestry Best Management Practices  
For Harvesting in South Carolina,  
2007-2008**



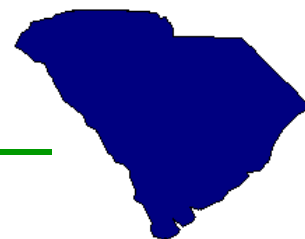
**Guy Sabin  
Environmental Program Manager  
South Carolina Forestry Commission**

**Best Management Practices  
Monitoring Report BMP-7**

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## EXECUTIVE SUMMARY

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Overall compliance with South Carolina's Best Management Practices for Forestry (BMPs) has increased to 98.6% for timber harvesting operations. This study documents continual improvement since compliance monitoring began in 1989. Results are based on the comprehensive evaluation of 138 recently harvested sites throughout South Carolina. Implementation of 105 different individual BMPs was considered. Each site was rated for compliance in several BMP categories, including road systems, road stream crossings, streamside management zones, harvesting systems, and overall compliance. Also, a review team of outside experts was invited to evaluate BMP implementation and effectiveness on difficult and borderline sites. Evaluation resulted in 91.3% agreement on overall compliance, demonstrating strong consensus on BMP implementation and identification of potential water quality impacts.



*BMP forester meeting with logging and forestry professionals.*





## INTRODUCTION

This is the eighth study conducted to determine BMP compliance rates during silvicultural activities since the current edition of South Carolina's Best Management Practices for Forestry (BMPs) was published in 1994. Seven of those studies reported compliance with BMPs related to timber harvesting, and three documented compliance during site preparation activities.

Overall compliance with BMPs (*Table 1*) related to harvesting rose to 98.6%, demonstrating continual improvement since compliance monitoring began in 1989. Harvesting compliance in 2006 was 98.0%.

Year of Publication	Harvesting BMP Compliance	Site Preparation BMP Compliance
1991	84.5%	
1993	84.7%	
1994	89.5%	
1996		86.4%
2000	91.5%	98.0%
2005	94.0%	96.0%
2006	98.0%	
2009	98.6%	

*Table 1: BMP Compliance by year of publication.*

During 2007-2008, 138 recently harvested sites were evaluated by specially trained BMP Foresters. Each site was rated for compliance in several BMP categories, including road systems, road stream crossings, streamside management zones (SMZs), harvesting systems related to site productivity, and harvesting systems related to water quality. Site evaluation included consideration of 105 individual practices described in *South Carolina's Best Management Practices for Forestry*.



Of the 138 sites evaluated, 1 was rated with Excellent Compliance, 135 with Adequate Compliance, and 2 sites with Inadequate Compliance. Major problems noted on inadequate sites were:

- Harvesting of the streamside management zone
- Failure to properly stabilize main skid trails
- Skid trail stream crossings not removed



*Log deck on a Piedmont site.*

## STUDY METHODS



During 2007 and 2008, 138 recently logged sites were evaluated for compliance and implementation of BMPs. A regional protocol for a consistent, credible, and statistically valid reporting process is presented in "Silviculture Best Management Practices Implementation Monitoring – A Framework for State Forestry Agencies," (Southern Group of State Foresters Water Resources Committee, 2007) All efforts were made to comply with this protocol. Compliance reporting is consistent with past BMP monitoring surveys conducted by the South Carolina Forestry Commission.

### Site Selection

Aerial surveys were utilized to remove bias during site selection. This monitoring survey was designed to sample sites from among all landowner classes, physiographic regions, soil types, and management regimes. Harvested sites selected were at least ten acres in size, had been harvested within the previous six months, and no site preparation activity had been conducted. No association with streams or wetland areas was required to be included as a monitoring site.

To begin, a total of 300 recently logged sites throughout South Carolina were identified by air. The number of sites located in each county was proportional to the annual timber harvest reported in US Forest Service Timber Product Output data.

Within each county, a random number generator was used to select half of the identified sites for inclusion in the study.

*Riparian forests contribute to water quality.*



Sample size was determined using the “Statistical Guide for BMP Implementation Monitoring,” (Southern Group of State Foresters Water Resources Committee, 2006). With estimated implementation of 96%, a sample size of 61 sites would be needed to achieve the desired 5% margin of error within the 95% confidence interval. By more than doubling the recommended sample size to 138, a margin of error of 1.5% is achieved for overall results.

## Landowner Questionnaire

Once a site was selected for inclusion in monitoring, the BMP Forester contacted each landowner to obtain permission to visit the site. Prior to the site inspection, each landowner was questioned concerning their level of familiarity with forestry BMPs, use of a professional forester, and use of a written contract. Four categories of landowners were identified for the purpose of this study:

- 1) Non-industrial private landowners who own less than 1,000 acres of forest land
- 2) Non-industrial private landowners who own more than 1,000 acres of forest land
- 3) Public lands, including both state and federal lands
- 4) Industrial lands, owned by forest products companies and timberland investment groups

## Site Evaluation

Site inspections were done by specially trained BMP Foresters. Each major category of BMPs was evaluated on a pass/fail basis depending on the responses to a series of yes/no/not applicable questions related to successful implementation of each BMP. On each site, 105 different individual BMPs were considered. BMP compliance was evaluated in each of five categories:

- 1) Road Systems
- 2) Road Stream Crossings
- 3) Streamside Management Zones (SMZs)
- 4) Harvesting Systems – Site Productivity
- 5) Harvesting Systems – Water Quality

Overall BMP compliance for each site was determined after all individual BMP categories were fully evaluated. Each site was given an overall rating of Excellent, Adequate, or Inadequate depending on the level of BMP compliance, as follows:

**Excellent Compliance** – All recommended BMPs were implemented successfully, and no water quality impacts resulted from the harvesting operation. Significant additional steps were taken to stabilize the site, reduce impacts to water quality or site quality, or to mitigate aesthetic impacts of the harvest.

**Adequate Compliance** – Recommended BMPs were sufficiently implemented to prevent water quality impacts from the harvesting operation.

**Inadequate Compliance** – Recommended BMPs were not implemented or were implemented without success. Likely water quality impacts were noted as a result of poor or improper BMP implementation.

## Compliance and Implementation

Determination of Excellent, Adequate, or Inadequate compliance with BMPs was closely linked with the likelihood or presence of water quality impacts, and was consistent with applicable state and federal water quality laws.

This study also includes analysis of BMP implementation, or the actual execution of applicable individual practices within each category. Implementation was noted as Yes, No, No with Significant Risk, or Not Applicable for each practice. Significant Risk indicates that there is a potential for future water quality impact should conditions degrade, and that deficiencies are correctable before such an impact occurs.

Failure to implement specific practices may or may not result in water quality impacts. For example, a site in hilly terrain may not have out-sloped roads as specified in BMPs, but other practices may have been implemented to achieve overall compliance. Compliance indicates whether a water quality impact is present or not, while implementation measures total performance of individual BMPs.



# MONITORING RESULTS



## Road Systems – 100% Acceptable Compliance

Roads were constructed to provide access for forest management activities on 57% of sites that were evaluated. During the field evaluation, BMPs for road construction and stream crossings on forest roads were considered separately.

A total of 470 applicable BMPs were evaluated on the sites with road construction.

*A well-stabilized haul road.*



Implementation rate of applicable BMPs was 94.7%. In all, 25 individual applicable practices on 17 sites were not properly implemented. Significant risk was noted on two sites, for lack of culvert stabilization and failure to stabilize exposed soil after construction, respectively.

Individual practices with the lowest implementation rates include:

- Roads designed to meet long-range objectives
- Waterbars used to retire limited use and main access roads
- Exposed mineral soil stabilized after construction
- Identified and avoided sensitive sites when possible
- Culvert inlets and outlets stabilized when installed
- Culverts and cross drainage large and frequent enough for expected water volume



Notably, 100% of roads were outside of streamside management zones. Roads were also well planned to avoid stream crossings when possible. Only 6% of sites with road construction included stream crossings.

The randomly located sites did not include any wetland road construction. Most forestry operations in wetlands successfully limit decks and roads to upland areas. Skidding operations within wetlands are covered in the category of Harvest Systems.

### **Road Stream Crossings – 88.9% Adequate Compliance**

In this survey, 7% of sites surveyed for compliance with BMPs involved the construction or improvement of haul road stream crossings. Of these, one site was rated as inadequate due to a road ditch that emptied directly into a stream and caused a water quality impact.



*Road ditch feeding into stream.*



*Excellent culvert installation.*

On the 9 sites with road stream crossings, a total of 79 applicable BMPs were evaluated. Three individual practices were improperly installed or not present, resulting in road stream crossing BMP implementation rate of 96.2%. Eight evaluated sites used a culvert crossing, and one used a bridge. The site with a bridge crossing rated highly in other areas, and was the only site in the study to receive an overall rating of Excellent.

The three practices not properly implemented occurred on two sites and were:

- Drainage structures used to prevent runoff into stream
- Culverts sized and installed following BMPs
- Disturbed soil at crossings stabilized soon after construction

The regional protocol recommends reporting of road stream crossings and skid trail stream crossings in a single category, while SC BMPs for Forestry include skid trail stream crossings in the category of Harvesting Systems. Combining data for road and skid trail stream crossings indicates 94.4% implementation of 179 applicable practices. Significant risk was noted on 3 individual practices.

## Streamside Management Zones – 95.4% Adequate Compliance

Perennial or intermittent streams were present on 48% of the sites included in this monitoring survey. Three sites were rated as inadequate primarily because of excessive harvesting within the SMZ.

A total of 780 individual practices relative to streamside management zones were evaluated with 98.5% implementation. Four significant risks were noted on three sites. Twelve individual applicable practices on eight sites were not properly implemented. Six of these problems involved overcutting within the streamside management zone, three involved failure to use directional felling and excessive debris in the stream channel, and three involved skidding within or altering the flow of ephemeral streams.



*A sufficient SMZ*



*Inadequate SMZ*



*Proper marking of SMZ*



*Excessive debris in an intermittent stream*



## Harvesting Systems – 97.8% Adequate Compliance

BMPs related to the harvesting operation were evaluated on each of the 138 sites included in this survey. Of these, 135 sites were rated as Adequate. The category of Harvesting Systems includes practices that could potentially impact water quality and/or site productivity, including log deck location, skid trail layout, skid trail stream crossings, degree of rutting, area affected by skidding equipment, and fuel and oil spills.

Three sites were rated as inadequate primarily because of failure to stabilize skid trails and failure to remove temporary crossings.



*From top left, use of bridge mats to cross ephemeral stream; a properly removed and stabilized skid trail crossing; a temporary debris crossing left in place; excessive rutting.*



*Left, Failure to stabilize a skid trail; Right, A temporary skid trail crossing.*

A total of 1,506 applicable practices were evaluated. Implementation rate of harvesting system BMPs was 96.4%. Significant risk was noted on eight sites, mostly involving unstabilized skid trails in or near streamside management zones and skid trail stream crossings. Individual practices not properly implemented were:

- Sensitive areas identified and avoided
- SMZs established adjacent to perennial or intermittent streams and lakes
- Skid trails kept out of streamside management zones
- Skidding over perennial or intermittent streams used adequate crossing
- Skidding over intermittent and ephemeral areas was protected with debris
- Use of fill avoided in skid trail stream crossings
- Temporary skid trail crossings were removed
- Primary skids trails on erosive slopes retired with water bars or seed
- Water flow on skid trails controlled with drainage structures
- Decks located on the most stable soils
- Equipment serviced away from water bodies or wetlands

Some practices are aimed at protecting site productivity, and are not directly related to water quality. Twenty-six applicable practices to protect site productivity were not properly implemented. Practices with the lowest implementation were:

- Site was logged when dry
- Lubricants and trash disposed of properly
- Steps taken to avoid depositing mud on roads



- Low impact system used when logging wet sites
- Skid trails stabilized with mats or debris to prevent excessive ruts
- Fuel or oil spills cleaned immediately

## Overall BMP Compliance for Harvesting – 98.6%

In this survey, overall compliance with BMPs related to timber harvesting in South Carolina was 98.6%, compared to 98.0% in 2006. Of the 138 sites inspected, 1 site was rated as Excellent, 135 as Adequate, and 2 sites were rated as Inadequate.

On sites that were rated as Inadequate, one or more BMPs were not implemented or were implemented incorrectly. As a result of deficiencies in BMP implementation, evidence was seen of a water quality impact. Examples of documented evidence of water quality impacts include sediment trails reaching a perennial or intermittent stream, algae blooms in a perennial or intermittent stream, and excessive logging debris within a stream channel.



*Unstabilized approach to skid trail crossing.*

*Skid trail on steep slope causing water quality impact.*



The sites with Inadequate overall compliance failed in the categories of Harvesting Systems and Streamside Management Zones. Both sites were on erosive upland clay soils with relatively steep slopes. A total of 16 specific deficiencies in BMP implementation were identified on the two sites, including:

On both sites –

- A forested streamside management zone 20' wide along perennial streams was protected instead of the recommended 40' SMZ
- 50 square feet of overstory basal area throughout the streamside management zone was not retained
- Water flow on skid trails was not controlled with drainage structures
- Primary skid trails on erosive slopes were not retired with waterbars or seed
- Streamside management zones were not established adjacent to perennial or intermittent streams or lakes

Single occurrences –

- Directional felling was not used
- Debris was not kept out of stream channel
- Water flow in ephemeral areas was altered
- Skid trails were not kept out of streamside management zones
- Skidding perpendicular to the contour was not minimized
- Skidding over perennial or intermittent streams did not use adequate crossing
- Use of fill was not avoided in skid trail stream crossings

## **Overall BMP Implementation**

Over the course of this survey, a total of 2,175 individual applicable BMPs were evaluated on 138 sites. Overall implementation rate of applicable BMPs was 96.8%.

## Significant Risk

Fifteen individual applicable BMPs on nine sites were noted for significant risk. Individual practices rated for significant risk included:

### Road Systems

- Culvert inlets and outlets stabilized when installed
- Exposed mineral soil stabilized after road construction

### Road Stream Crossings

- Ditch runoff kept out of stream at crossing

### Streamside Management Zones

- Recommended width SMZ protected
- On perennial streams, retain 50 BA overstory, evenly spaced
- Debris kept out of stream channel

### Harvesting Systems

- Water flow on skid trails controlled with drainage structures
- Skidding over perennial or intermittent streams used adequate crossing
- Use of fill avoided in skid trail stream crossings
- Primary skid trails on erosive slopes retired with waterbars or seed
- Equipment serviced away from water bodies or wetlands
- Skid trails kept out of SMZs and stream channels
- Skidding over intermittent and ephemeral areas was protected with debris
- Temporary skid trail crossings were removed

## SUMMARY AND DISCUSSION



Overall compliance with silvicultural BMPs related to timber harvesting was 98.6% in this study. Harvesting compliance has steadily increased since the first monitoring conducted in 1989. The regional average among 13 southeastern states for overall BMP implementation during harvesting is 89%, compared to 96.8% for South Carolina (*Implementation of Forestry Best Management Practices-A Southern Region Report*, Southern Group of State Foresters Water Resources Committee 2008). The overall ratings indicate that the South Carolina BMP Program is highly successful, and that landowners, loggers, and forestry professionals demonstrate strong commitment to protecting water quality.

By categories, Road Stream Crossings had the lowest compliance at 88.9%. This category also showed the greatest drop in compliance from the previous survey (*Figure 1*).

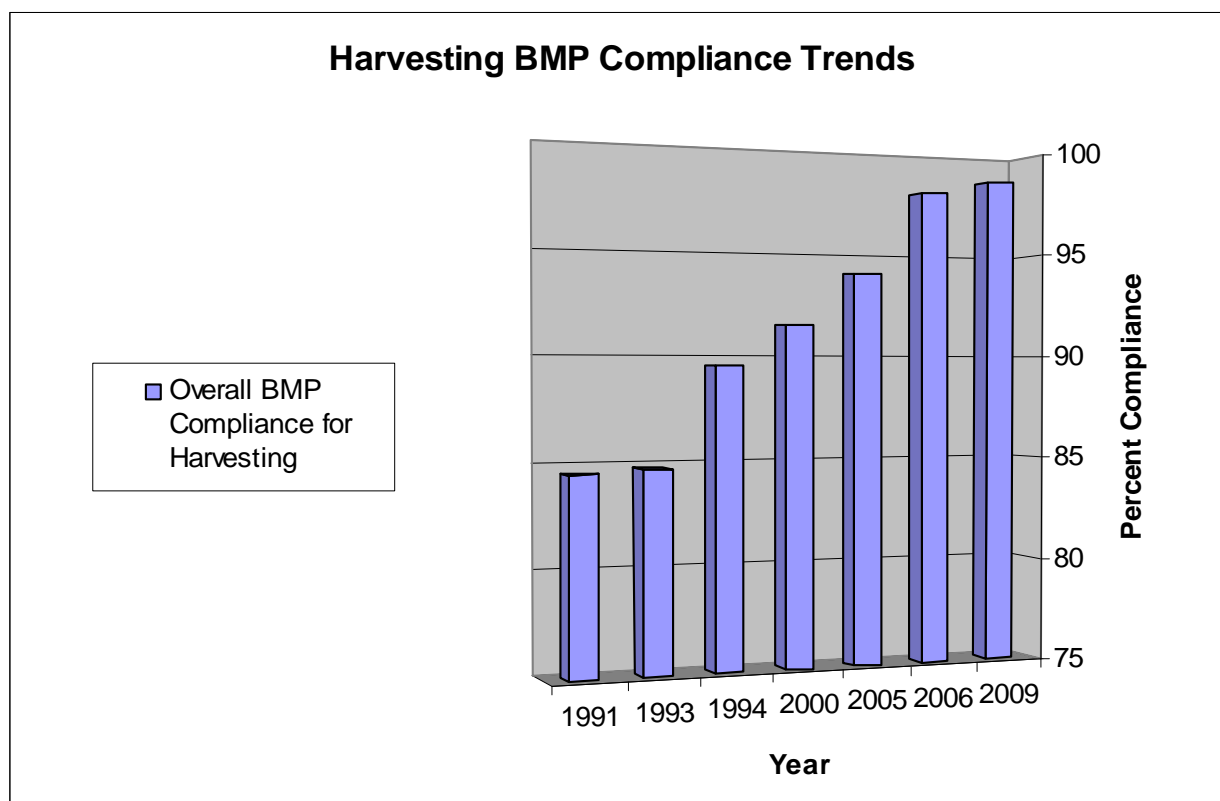


Figure 1

Most harvests successfully avoided road stream crossings where possible, and the level of compliance confirms the high potential for water quality impacts from this activity. All other categories showed compliance above 95% (*Figure 2*).

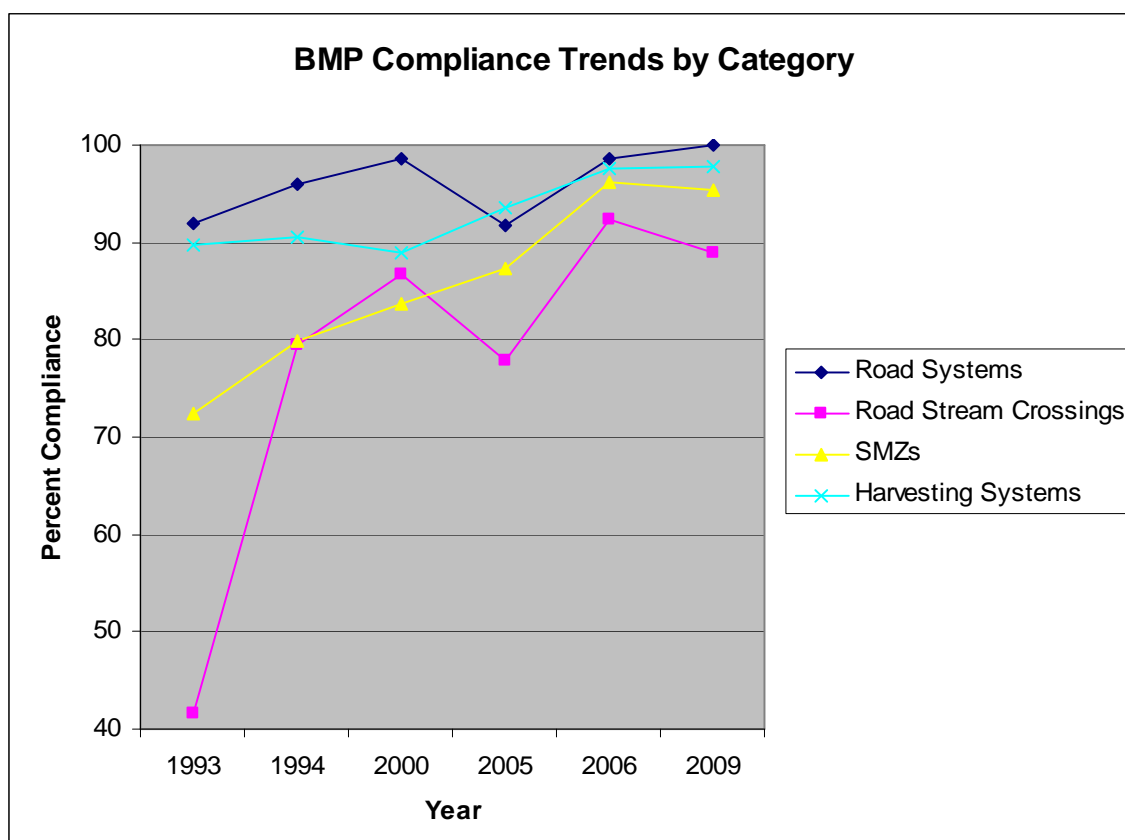


Figure 2

Ownership category had little impact on BMP compliance in this survey (*Table 3 and Figure 3*). Implementation rates by ownership were also fairly consistent:

<u>Ownership Category</u>	<u>2009 Compliance</u>	<u>2009 Implementation</u>
Public	100%	100%
Industry	97.2%	97.8%
NIPF > 1,000	100%	97.1%
NIPF < 1,000	98.6%	95.5%

Table 3: Compliance and Implementation by ownership class.

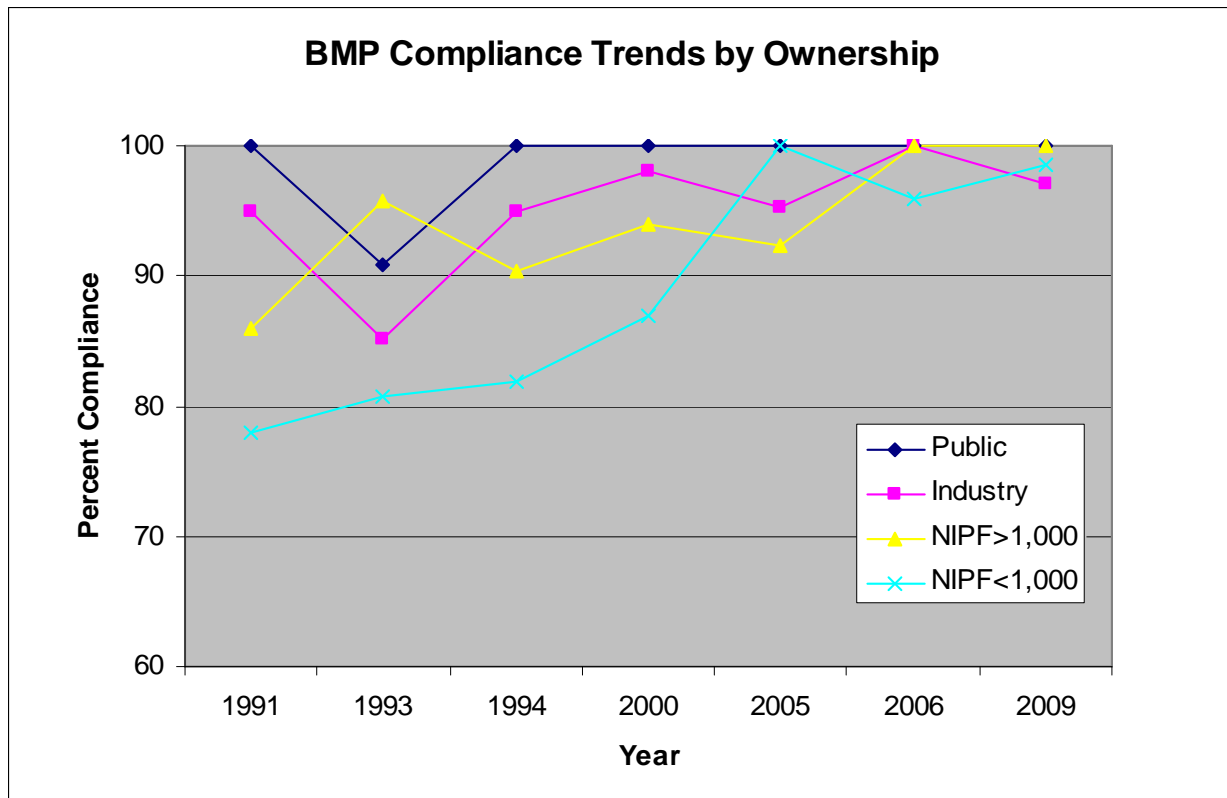


Figure 3

As part of the survey, each landowner was questioned about their familiarity with BMPs, use of a professional forester, and use of a written contract during harvesting.

- The average harvest size in this study was 73 acres.
- 61% of all landowners were familiar with BMPs.
- Only 31% of non-industrial private landowners with less than 1,000 acres were familiar with BMPs.
- 83% of landowners relied on the assistance of a professional forester during harvesting. (Note that some landowners may have reported involvement by non-registered wood buyers in answering this question.)
- 92% of landowners had a written contract.
- 62% of landowners with a written contract required BMP compliance as part of that contract.
- 45% of non-industrial private landowners with less than 1,000 acres required BMPs compliance as part of that contract.



Sites rated as Inadequate had no commonalities other than physiographic region. Both Inadequate sites occurred in the southern Piedmont, had upland clay soils, and moderate to steep slopes. Past monitoring surveys have established that this combination presents the greatest risk for erosion and sedimentation resulting in a water quality impact.

Landowners included in this survey were assured that no regulatory enforcement or other repercussions would result from participating in this study. This approach is essential for continued access to private lands needed to avoid bias in the random sample. However, follow-up actions were taken when significant risks or water quality impacts were noted. Landowners were notified of any BMP deficiencies, and technical assistance was offered to help correct any potential water quality problems.



*BMP forester discusses an operation with a consulting forester.*

*Clambunk skidder on a bottomland harvest.*





## EXPERT REVIEW

A group of outside experts were invited to evaluate BMP implementation and effectiveness on difficult and borderline sites. This review provided a valuable opportunity to consider how specialists in related fields view potential water quality impacts from timber harvesting, and offer feedback on SC BMPs for Forestry.

The review team included individuals well-regarded for their knowledge in areas such as aquatic ecology, hydrology, wildlife biology, water chemistry, soil science, and wetlands, as well as forest management and harvesting operations. This expertise was drawn from regulatory, management, academic, private, and government sources. Representatives from U.S. Army Corps of Engineers, U.S. Forest Service, U.S. Fish and Wildlife Service, SC Department of Health and Environmental Control, SC Department of Natural Resources, Clemson University, forest industry, forestry consultants, and professional loggers participated.

In order to maximize discussion and highlight differences, sites were deliberately selected based on challenging operational conditions, difficult stream classifications, and marginal or poor BMP implementation.

Evaluation consisted of each team member completing a BMP Courtesy Exam form for each site. Group discussion of individual BMP practices and overall compliance provided further insights.

A total of thirteen sites were visited by the team, and 106 individual evaluations were completed.

### BMP Compliance

Overall BMP compliance for all sites was rated at 80.6% by the full group. As expected, this was substantially lower than statewide BMP compliance because of the site selection criteria. Compliance by BMP category showed similar results based on the nature of sites selected. (*Table 4*)

BMP Category	Compliance
Road Systems	87.5%
Road Stream Crossings	78.0%
Streamside Management Zones	77.9%
Harvesting Systems	80.0%
Overall	80.6%

*Table 4: Compliance by BMP category.*

## Level of Agreement

The group was in 91.3% agreement on overall compliance. This suggests that experts from related fields, regardless of forestry or timber harvesting experience, share similar views on BMP implementation and identifying potential water quality impacts.

Overall level of agreement was determined by the number of equivalent answers for each site. All reviewer categories had agreement greater than 90%.

Reviewers were in 100% agreement on 8 of the 13 sites visited, and 90% agreement on one site. Four sites had agreement less than 90%: Florence 1, Kingstree 1, Kingstree 2, and Orangeburg 3.

**Florence 1** was a clearcut harvest with a well-buffered perennial stream and a smaller tributary stream which provided the source of disagreement. The tributary stream collects significant agricultural and urban runoff, was ditched in places, and does not appear on USGS topographic maps. The operator left some trees within the drainage area and considered this to exceed BMP guidelines since the stream had such poorly defined banks and separated into multiple channels. However, equipment crossed the stream at several locations. Water flow was present during the October 2008 site visit.

A team of six reviewers visited this site and four rated the site as Adequate overall, resulting in 67% agreement. Two Regulatory observers rated the site as Inadequate overall due to on-site impacts and altered flow in the tributary stream, classed as intermittent. One observer considered the tributary stream to be perennial.

Several reviewers noted BMP deficiencies, but rated the site as Adequate. One observer noted that the tributary stream fed into a low grassy area and would not likely deliver sediment into the main stream.



*Buffered tributary stream on  
site Florence 1*





*Left, a view of the tributary stream on Florence 1; right, rutting at a crossing location.*

**Kingstree 1** included a stream which transitioned from intermittent to perennial within the harvested area. The operator harvested trees along the bank in the upper reaches of the stream, and retained a forested SMZ beginning where additional water flow from an agricultural pond outlet ditch entered the stream.

This site had a 50% level of agreement, the lowest in this review. All six observers indicated that Streamside Management Zones were not sufficient, and five observers also failed the Harvesting Systems category.

The site included multiple skid trail stream crossings, skidding within the SMZ, and stream banks that were not protected. The site was clearly not in compliance with SC BMPs for Forestry, but the group was evenly split in judging whether a water quality impact was present.



*Stream and skid trail crossing on site Kingstree 1.*

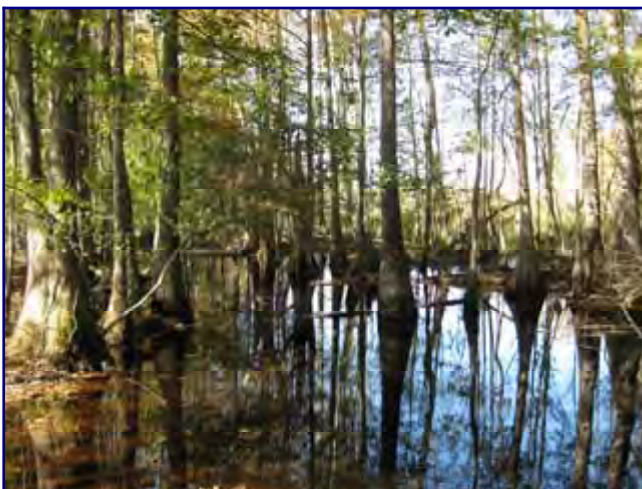
*A poorly planned skid trail crossing on Kingstree 1, with skidding in SMZ.*



One reviewer indicated that although the harvest was poorly planned, ongoing in-stream impacts were not apparent. Distinguishing perennial and intermittent streams may have played a role in the overall rating. One reviewer rated the site as Adequate, "in spite of multiple crossings of an intermittent stream." Recommendations for remediation ranged from allowing the site to heal naturally to full stream restoration.

**Kingstree 2** was a bottomland hardwood harvest on the edge of Douglas Swamp, and included a perennial stream. Harvesting began on the downstream portion of the tract when the site was flooded. Appropriate logging equipment and techniques for the conditions were not used. The perennial stream was completely submerged, and was not recognized or protected. When the water level receded, the operator identified the stream and began protecting an appropriate SMZ.

This site was rated as Inadequate by five of six reviewers, resulting in agreement of 83%. All reviewers rated Streamside Management Zones as insufficient, and three failed the Harvesting Systems category. The single reviewer who rated the site as Adequate overall qualified that decision with notes that the site was extremely difficult to call, and would require additional resources such as aerial imagery and a more thorough evaluation of the entire site to determine the relationship between this stream and the main channel in order to make a conclusion.



*Left, stream section with adequate SMZ; right, further down the same stream a SMZ was not retained on Kingstree 2.*





*Left, a skid trail crossing location; right, a reviewer checks algae growth in the stream on Kingstree 2.*

**Orangeburg 3** was a harvest in a riparian area surrounded by agricultural use. The stream appears as first-order intermittent on USGS topographic maps with a watershed of about 200 acres. Sections upstream were ditched for agricultural and road drainage. Downstream, banks became poorly defined as it joins Middle Pen Swamp.

This site was reviewed by a team of eight people, two of whom rated the site as Inadequate resulting in 75% agreement. Stream classification was the primary point of disagreement. Four observers classified the stream as intermittent with Adequate protection, and two considered the stream to be perennial with Inadequate protection. Three observers rated the Streamside Management Zone category as insufficient, but two of those rated the overall site as Adequate due to trees left on the bank and stabilization provided by other vegetation.



*The group considers stream classification on site Orangeburg 3.*



*Additional views of the stream on Orangeburg 3.*

## Expert Review Discussion Issues

Group discussion and interaction within the review team was arguably the most important part of this review. Reviewers frequently confirmed that sites visited were indeed challenging, and often agreed that calls could easily have been made either way. The following issues generated the most discussion:

1) **Stream classification** is a critical decision point for proper BMP implementation. Failure to correctly distinguish between perennial and intermittent streams may result in either inadequate stream protection or unnecessary loss of timber income. Perennial streams are defined as having water flow 90% or more during a normal year. Indicators such as a clearly defined channel, firm sandy bottom, lack of debris, and lack of non-aquatic vegetation in the stream channel help identify such streams. Intermittent streams may also have a well-defined channel, but flow from 30% - 89% of a normal year. Less frequent water flow may result in a layer of silt and organic debris in the stream channel, along with growth of non-aquatic vegetation.

Problems arise when storms flush out streams, periods of dry weather reduce water flow, and indicators may manifest differently by soil types and terrain. Features such as river sloughs, multiple channels, gullies, channelized streams, and ditches pose additional challenges. Coastal plain streams were especially difficult to classify.

Many differences in how individual sites were rated were based on whether a stream was considered to be perennial or intermittent. The same activities may have been considered excellent protection of an intermittent stream by one reviewer and inadequate protection of a perennial stream by another. Although clear criteria for stream classification were desired, reviewers noted that this will always be somewhat subjective. Several reviewers indicated that the disparity in recommended guidelines for perennial and intermittent streams compounds this issue.



- 2) **Heightened protection of intermittent streams** was recommended by several reviewers. SC BMPs for Forestry allow removal of permanent residual tree cover along intermittent streams as long as other vegetation and organic debris are left to protect the forest floor and stream banks. Additional guidelines address minimizing soil exposure and crossings, protecting bank stability, and keeping debris out of streams. Most believed these recommendations adequate for small channels, but high level intermittent streams and borderline perennial streams should receive additional protection. Some reviewers suggested applying perennial stream recommendations with a narrower buffer width for intermittent streams. This issue will be considered further when SC BMPs for Forestry are next updated.
- 3) **Stabilization of stream crossing approaches** was an issue of concern on most sites with crossings. The group was pleased with installation and use of stream crossings, but frequently indicated that additional stabilization was in order after temporary crossings were removed. Use of debris, seed, mulch, silt fence, and hay bales were most often suggested to prevent sedimentation at crossing sites.
- 4) **Evaluation of existing roads** raised questions about logger responsibility for problems that existed prior to harvesting. SC Forestry Commission and Forestry and Logging Professionals noted potential impacts from road ditches emptying into streams and replacement of undersized culverts, but few in other reviewer categories considered these to be significant issues.
- 5) **Corrective action** was generally preferred over enforcement when possible. Many reviewers felt that education, guidance, and follow up to correct problems and prevent any on going impacts effectively address noncompliance. However, the Sustainable Forestry Initiative Program and enforcement by regulatory agencies are important parts of an overall system resulting in high BMP compliance.

Related discussion centered on the value of site remediation versus the additional impact from soil disturbance caused by cleaning out stream channels and re-shaping stream banks. The group agreed that the potential benefits and impacts from requiring an additional entry to the site must be considered on a case-by-case basis.

## Expert Review Conclusions

Overall results suggest strong consensus among a diverse range of experts that SC Best Management Practices for Forestry effectively protect water quality when properly implemented. Evaluation of water quality impacts resulted in a relatively high level of agreement (91.3%) regardless of reviewer category or area of expertise. Reviewers noted the efforts made towards BMP compliance even on sites selected for problems, and expressed overall satisfaction and support for SC BMPs and the Courtesy Exam program.

Dr. Tom Williams, forest hydrologist with Clemson University Baruch Institute of Coastal Ecology and Forest Science, was a co-author of the first SC BMP compliance survey in 1991. After participating on this expert review he wrote, "I was impressed with the strides that have been made since my first review in the early 1990's. South Carolina is still a leader in voluntary forestry BMPs. The combination of trained loggers, Sustainable Forestry Initiative Program (SFI) compliance in mills, and the Commission's BMP Foresters has certainly proved to be highly effective to protect water quality in harvesting operations."



Issues identified in this review will be used to target logger training programs, receive increased emphasis during Courtesy Exams, and form a foundation for the next SC BMP manual update.



*Site preparation with bedding for seedling survival.*



*Good waterbar construction.*

# RECOMMENDATIONS

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Since regular monitoring of BMP implementation began in South Carolina in 1989, overall compliance has continued to improve. Many factors have contributed to the increased compliance with and awareness of forestry BMPs:

- Educational efforts on active forestry operations through the SCFC Courtesy BMP Exam program
- Targeted training to address areas of low BMP implementation
- Increased availability of training for loggers, foresters, and forest landowners
- Support from companies that participate in the American Forest & Paper Association's Sustainable Forestry Initiative program
- Improved cooperation between state agencies, federal agencies, and private organizations
- Improved cooperation between SCFC and regulatory agencies for consistency when enforcement actions are initiated
- Increased professionalism in the logging community

The BMP Courtesy Exam program is designed to prevent water quality impacts by providing technical assistance and advice on active forestry operations. Specially trained BMP Foresters locate sites through aerial and ground observation, voluntary notification, and complaints. During a Courtesy BMP Exam, the BMP Forester evaluates the site and provides the operator with site-specific recommendations to properly implement BMPs on the tract. The operator is given an opportunity to correct any deficiencies that exist. When excessive damage has occurred, resulting in a likely water quality impact, deficiencies are noted on the monthly Courtesy Exam Report. Through this report, the site is referred to the SC Department of Health and Environmental Control for possible enforcement action, and to forest industry. Forest industry utilized the report to determine when corrective action and additional training is necessary for their suppliers.

In cooperation with the South Carolina Forestry Association and Clemson University, logger training through the Timber Operations Professional (TOP) Program has been in place since 1994. Initial training in the TOP Program includes a basic understanding of BMPs, and continuing education provides opportunities for more in-depth training. Revisions to continuing education requirements now specify that BMP-related training must be completed every three years. As a result of problems noted in past monitoring surveys, additional workshops have been created to address BMPs for streamside management zones, harvest planning, and forest road construction. Continuation of this program and participation by forest industry is essential to further improve compliance with BMPs.

## Developing Issues

### Wetland Roads

The randomly selected sites in this survey did not include any wetland road construction, and such sites cannot be added to the survey without introducing bias. Activities in the BMP Courtesy Exam program indicate that wetland roads are a source of public and regulatory concern, generate many complaints, and frequently require remediation to achieve BMP compliance. Therefore, it is recommended that special attention be devoted to wetland roads in a future survey.

### Mud on Roads

Measures to avoid depositing mud on roads were taken on 85% of applicable sites. This issue is not directly related to water quality, but has a large impact on public opinion. Mud on roads is normally considered a public safety hazard under jurisdiction of law enforcement agencies, and may also jeopardize encroachment permits for logging driveways. Damage to paved roads and maintaining ditches are often corollary concerns. Local governments and SC Department of Transportation districts have been prompted to consider solutions ranging from additional regulation to performance bonds. Improved performance where this individual BMP is applicable may become increasingly important to avoid restrictions on unmanufactured forest products trucking. The SC Forestry Association and SC Timber Producers Association have been actively involved with this issue.

### Small Landowners

Non-industrial private landowners with less than 1,000 acres own the majority of land in South Carolina. Yet only 31% in this survey indicated that they are familiar with BMPs. Only 45% of small landowners required BMPs during harvesting in a written contract. This is a significant drop from 83% reported in 2006. The 2006 survey also found that landowner awareness of BMPs and expectations of compliance played an important role in overall BMP compliance. This decline in including BMP compliance in written contracts emphasizes the need for increased outreach to small landowners. The fact that compliance rates remained high shows the value of a well-trained professional logging force.

### Future Surveys

The regional protocol for BMP Implementation Monitoring recommends additional categories that should be surveyed. Site preparation (mechanical, chemical, and burning), firebreaks, and forest chemical application (fertilization and herbicides) should all be evaluated as part of regular BMP monitoring. In South Carolina these categories were last addressed in 2005. Further, implementation and compliance for "SC's BMPs for Braided Stream Systems: A Supplement to the 1994 BMP Manual," (1999) have not been evaluated. These categories should be included in a future survey.

### BMP Update

The current BMP manual was developed in 1994. An update should be considered to incorporate new research and provide additional guidance for emerging and sensitive issues such as biomass harvesting and wetland logging. The Southern Group of State Foresters Water Resources committee has conducted a literature review and developed a new slope profile computer model that may be useful in updating the BMP manual. Based on results of

the Expert Review, stream identification, intermittent stream protection, and treatment of existing roads should be considered.

## Continual Improvement

Three areas emerged from this survey as opportunities to improve implementation and reduce potential water quality impacts. Training programs and Courtesy Exams should emphasize these topics to further improve BMP compliance:

1) **Stream crossings** on both road systems and skid trails have a high potential for water quality impacts, so proper implementation of applicable BMPs is critical. The most significant issues are:

- Keep ditch runoff out of streams at crossings
- Use adequate crossings when skidding over perennial and intermittent streams
- Avoid the use of fill in skid trail stream crossings
- Ensure temporary skid trail crossings are removed and adequately stabilized

2) **Streamside management zones** play a vital role in protecting riparian areas. Economic stress increases the challenge for landowners and forestry operators to leave sometimes valuable timber within an SMZ. Both Inadequate sites in this survey had problems related to SMZs. The most important areas to emphasize are:

- Establish SMZs that meet the recommended primary and secondary widths for perennial and intermittent streams and water bodies
- On perennial streams, maintain 50 square feet of overstory basal area evenly distributed in the primary zone, or leave all trees if 50 BA is not present
- Keep tops and debris out of streams
- Ensure that stream classification is accurately determined

3) **Skid trails** emerged as the greatest source of problems in the Harvesting Systems category, especially regarding stabilization. Practices to focus on include:

- Control water flow on skid trails with drainage structures such as broad-based dips, wing ditches, or water bars
- Retire primary skid trails on erosive slopes by installing water bars and seeding
- Keep skid trails out of streamside management zones
- Skidding over intermittent and ephemeral areas should be protected with debris
- Use woody debris, mats, or other techniques to stabilize skid trails if excessive rutting is occurring

In order to maintain high BMP compliance and continually improve implementation, the following suggestions should be enacted:

- BMP educational opportunities such as TOP Programs and workshops should continue to be offered regularly and with minimal cost to forestry operators. New classes should be developed to further advance BMP awareness and target priority issues identified in this survey.
- The Courtesy BMP Exam program should be continued. This preventative program provides opportunities for one-on-one training for loggers, road construction contractors, and site preparation contractors. Follow up by SCDHEC and forest industry ensures that problems are remediated.
- Additional efforts should be made to increase awareness of BMPs among small private landowners, and encourage inclusion of BMP compliance in written contracts.

